



TITLE:

# RECENT FORAMINIFERA THANATOCOENOSSES OF BEACH AND NEARSHORE SEDIMENTS ALONG THE COAST OF WAKAYAMA- KEN, JAPAN

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RIGHT:

# RECENT FORAMINIFERA THANATOCOENOSSES OF BEACH AND NEARSHORE SEDIMENTS ALONG THE COAST OF WAKAYAMA-KEN, JAPAN

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*With 2 Tables and 1 Text-figure*

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## Introduction

As a part of the ecological study of Recent Foraminifera around the Japanese coast, five beach-sand samples and four nearshore sediment samples along the coast of Wakayama-ken have been studied for a quantitative analysis of Foraminifera assemblages. The locations of these samples are shown in Figure 1.

The beach-sand samples were collected by the writer in April, 1951 at Wakaura, Wakayama-shi; Shiraki and Nishihiro, Hiro-chō, Arita-gun; Seto (near the Seto Marine Biological Laboratory), Shirahama-chō, Nishimuro-gun; and near the Kushimoto Railway Station, Kushimoto-chō, Nishimuro-gun. Among them, the sample at Kushimoto was collected in a special way as follows. As waves retreat in ebb tide, they leave small patches of white part on the surface of ripple marks. The white patches are, in reality, concentrations of Foraminifera tests by natural processes. As the result, this white part has a much larger population than the other samples per unit weight or volume of sediment, and the characteristics of the Foraminifera assemblage may be different from those collected in an ordinary way. However, the writer believes that the Foraminifera assemblage represents a general aspect of the intertidal assemblage since the sizes of the foraminiferal tests are variable and this fact suggests that the sorting process of sediment particles (including foraminiferal tests) by surf was not too strong there.

The four nearshore sediment samples were collected in and near Mori Harbor by members of the Hydrographic Office of Japan on August 26 and 28, 1954 using a dredge. The exact locations of them are as follows:

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Station No.	1	2	3	4
Depth (m)	7.0	6.4	2.9	8.6
N. Lat.	33° 42' 48"	33° 42' 57"	33° 43' 00"	33° 42' 37"
E. Long.	135° 23' 48"	135° 23' 54"	135° 24' 04"	135° 23' 12"
Sediment	mud	mud	mud	mud & sand

The writer wishes to express his cordial thanks to Mr. Takahiro SATO of the Hydrographic Office of Japan for giving the sediment samples of Mori Harbor to the writer, Prof. Takasi TOKIOKA of the Seto Marine Biological Laboratory of

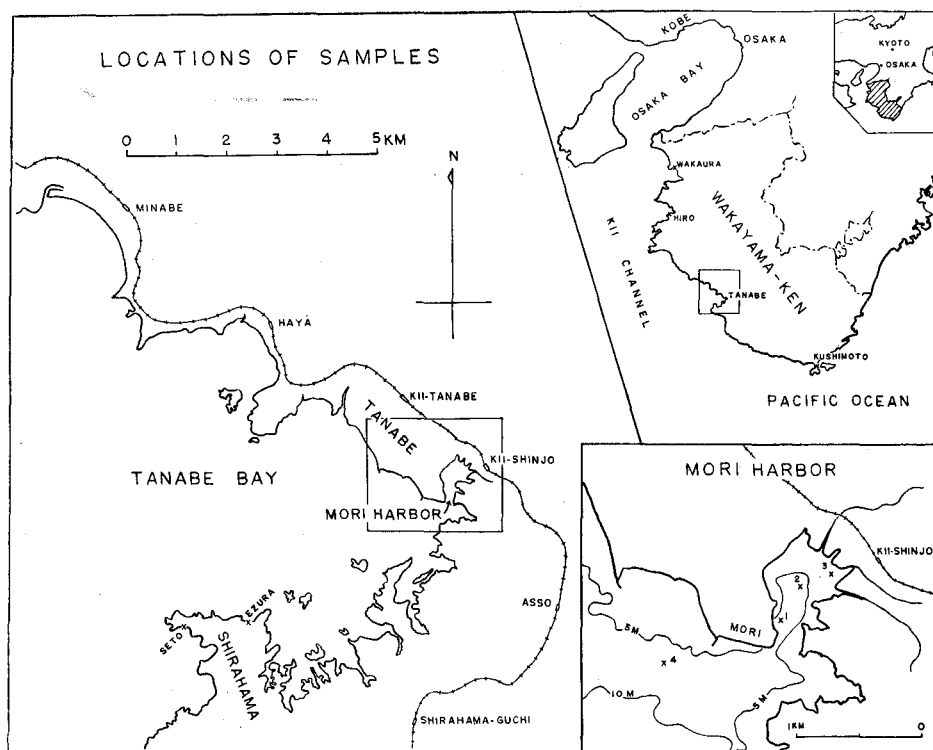


Figure 1.

Kyoto University, and to Prof. Tomofusa MITSUCHI of the writer's institute for their constant encouragements and advices.

### General Statements

The coast under discussion is the western coast of Kii Peninsula. The shoreline is rather complex, showing very many indentations, suggesting recent subsidence of land. The coast is rocky in most part, and the northern part (from

Wakayama-shi to Minabe-chō, *ca.* 7 km northwest of Tanabe-shi) consists of Paleozoic and Mesozoic formations, while the southern part (from Minabe-chō to Kushimoto-chō) consists of Cenozoic (Miocene and Paleogene) formations. Therefore, derived fossil Foraminifera from these formations, if present in the Recent sediment, can be easily distinguished from Recent Foraminifera. The coast is under the influence of the warm Kuroshio Current flowing through Kii Channel towards north.

Concerning the productivity of Tanabe Bay, field surveys were made in November, 1956 and in August, 1957, and fourteen papers were published by MIYADI, HAYAMI and their collaborators in 1958 and 1959. From these results, the hydrography of Tanabe Bay is briefly described as follows:

(1) November, 1956... "Water temperature varied from 20.28°C to 23.14°C. Temperatures on the surface layer were more variable than on the other layers. Differences on the surface were 2.76°C, on both the 5 and 15 meter layers were 1.15°C, and on the bottom were 1.83°C. Tracing the isothermal lines, it is recognizable that in general temperatures were lower from the entrance towards the inner parts and warmer waters in the mouth entered towards southeast. As to the vertical distribution, surface temperature was generally higher than bottom temperature and its average range for all stations was 0.4°C... The highest chlorinity measured at the surface was 18.96‰ and the lowest 14.35‰. Open sea water entered the bay in the form of wedge. In the innermost arms and estuaries of the rivers Aizu-gawa and Haya-gawa, discharge of fresh water seemed to have any appreciable effect upon chlorinity of the bay water, showing the low chlorinity less than 18.00‰. In Mori arm (harbor), its effect was the most remarkable, but seemed to be confined only to the surface water. Vertical ranges of chlorinity were small, the maximum value being 4.42‰ (Mori arm), minimum 0.00‰ and mean 0.3‰... In general, concentration of inorganic silicate found in the inner region was higher than in the outer, with decreasing tendency towards the open sea. It showed a tendency becoming lower from surface to bottom. Higher concentration was found in the five arms and in the northwest area where the river water pours into the bay (1.04 mg/L at the surface water in Mori arm). These facts prove the great effect of fresh water pouring into the bay and coincide well with the distribution figure of surface chlorinity... Inorganic phosphate were distributed in patches. In general, it had a tendency that concentration becomes lower towards the outer region from the innermost and towards the bottom from the surface. High concentrations of phosphate were found on the surface at Mori arm (0.0487 mg/L), Utinoura *ca.* 0.025 mg/L..." (FUSE, YAMAZI & HARADA, 1958).

(2) August, 1957... The average surface temperature along a traverse at the entrance of the bay (5 stations) was 27.8°C and the bottom water temperature 23.5°C... Along the same traverse, the average surface chlorinity was 18.25‰

and the average bottom chlorinity was 18.74 ‰ (FUSE, 1959). Chlorinity near the entrance of Mori arm) was 16.88 ‰, 18.56 ‰ and 1.75 ‰ at depths of 0.5 and 10 m respectively (HAYAMI & FUKUO, Figs. 4, 5, 6, 1959).

### Foraminifera Thanatocoenoses

Occurrences of the benthonic Foraminifera are listed in Table 1. The high order taxonomic grouping, such as family, is artificial and the recent scheme of LOEBLICH & TAPPAN (1960) is used tentatively in the table. Table 2 is a simplified form of Table 1 to show the general features of the sediment samples. In this table, LOEBLICH & TAPPAN's Rotaliidae and Discorbidae are grouped in one unit (CUSHMAN's Rotaliidae, 1948), and Buliminidae, Bolivinitidae and Uvigerinidae in one unit (CUSHMAN's Buliminidae).

Grain size analysis of these samples was not made. Percentages of sand (larger than 0.061 mm in diameter) content of the samples are listed in Tables 1 and 2. In Mori Harbor the sand content increases from head of the harbor (Sta. 3) to the entrance (Sta. 1) and farther offshore (Sta. 4). This may be due to the fact that the inner part of the harbor is protected from strong wave action of Tanabe Bay. Organic content of the harbor sediments is much higher than that of the beach sand. Average size of the beach sand is fine to medium at Kushimoto and coarse at the other localities.

The following generalization of Foraminifera distribution may be made from Tables 1 and 2:

- (1) Types of the Foraminifera assemblages are:

Wakaura .....	<i>Elphidium</i> (mostly <i>advena</i> and <i>jenseni</i> )— <i>Ammonia beccarii</i> — Miliolidae Assemblage
Shiraki .....	<i>Ammonia nipponica</i> — <i>Elphidium crispum</i> Assemblage.
Nishihiro .....	<i>Elphidium</i> (mostly <i>crispum</i> and <i>craticulatum</i> )— <i>Marginopora hemprichii</i> —Miliolidae Assemblage.
Ezura <sup>1)</sup> .....	<i>Amphistegina lessonii</i> — <i>Elphidium craticulatum</i> Assemblage.
Seto .....	<i>Amphistegina lessonii</i> Assemblage.
Kushimoto .....	<i>Elphidium</i> (mostly <i>crispum</i> and <i>jenseni</i> )— <i>Cibicides refulgens</i> — <i>Ammonia beccarii</i> —Miliolidae Assemblage.
Mori Sta. 4 .....	<i>Ammonia beccarii</i> — <i>Elphidium</i> —Miliolidae Assemblage.
Mori Sta. 1 .....	<i>Ammonia beccarii</i> — <i>Elphidium</i> (mainly <i>subincertum</i> ) Assembl.
Mori Sta. 2 .....	<i>Ammonia beccarii</i> — <i>Elphidium</i> (mainly <i>subincertum</i> ) Assemblage
Mori Sta. 3 .....	<i>Ammonia beccarii</i> —Arenaceous Foraminifera (mainly <i>Trochammina</i> cf. <i>globigeriniformis</i> ) Assemblage.

1) More than 3000 specimens were counted at this locality. Important species are *Amphistegina lessonii* (65%), *Elphidium craticulatum* (24%), *Quinqueloculina* spp. (10%). *Marginopora hemprichii* and *Camerina ammonoides* are rare.

Table 1. Occurrences of benthonic Foraminifera in percent of total (living plus dead) population. (R=rare)

Stations	Beach sand					Mori Harbor			
	Wakaura	Shiraki	Nishihiro	Seto	Kushimoto	3	2	1	4
Depth (m)	0	0	0	0	0	2.9	6.4	7.0	8.6
% of sand content in sediment	100	100	100	100	100	45	66	65	70
Benthonic Population in 5 g of dried sediment	15	485	443	174	2884	340	514	732	528
<b>ARENACEOUS FORAMINIFERA</b>									
Ammodiscidae									
<i>Glomospira gordialis</i> (JONES & PARKER)	—	—	—	—	—	R	—	.3	R
Aschemonellidae									
<i>Reophax</i> cf. <i>nanus</i> RHUMBLER	—	—	—	—	—	.1	.2	R	R
<i>R.</i> <i>scottii</i> CHASTER	—	—	—	—	—	.9	.4	R	.2
<i>R.</i> sp.	—	—	—	—	—	—	—	—	.2
Lituolidae									
<i>Haplophragmoides</i> sp.	—	—	—	—	—	.1	—	—	—
<i>Alveolophragmium</i> cf. <i>jeffreysii</i> (WILLIAMSON)	—	—	—	—	—	—	—	—	.4
<i>Ammoscalaria</i> sp. A	—	—	—	—	—	.6	.1	.7	.2
<i>Ammobaculites</i> cf. <i>agglutinans</i> (D'ORBIGNY)	—	—	—	—	—	R	—	—	R
Textulariidae									
<i>Textularia</i> cf. <i>pseudogramen</i> CHAPMAN & PARR	—	.8	.7	.4	.4	—	—	—	—
<i>T.</i> <i>conica</i> D'ORBIGNY	—	.6	—	—	.2	—	—	—	—
<i>T.</i> <i>earlandi</i> PARKER	—	—	—	—	—	.3	.1	.2	.1
<i>T.</i> <i>fistula</i> CUSHMAN	—	—	—	—	.2	—	—	—	—
<i>T.</i> <i>kerimbaensis</i> SAID	—	.4	.2	—	.2	—	—	R	.2
<i>T.</i> <i>sagittula atrata</i> CUSHMAN	—	.2	—	—	.1	—	—	—	—
<i>T.</i> cf. <i>candeiana</i> D'ORBIGNY	.4	—	—	—	.1	—	—	—	—
<i>T.</i> sp. A	—	—	—	—	—	.3	—	R	R
<i>T.</i> sp. B	—	—	—	—	—	—	.2	—	—
Trochamminidae									
<i>Trochammina</i> cf. <i>globigeriniformis</i> (P. & J.)	—	—	—	—	—	.9	.1	.8	—
<i>T.</i> cf. <i>pacifica</i> CUSHMAN	—	—	—	—	—	—	.1	.1	.6
<i>T.</i> <i>squamata</i> PARKER & JONES	—	—	—	—	—	—	—	—	R
<i>T.</i> sp. A	—	—	—	—	—	.6	.6	.1	.2
<i>T.</i> sp. B	—	—	—	—	—	.6	—	—	—
Ataxophragmiidae									
<i>Gaudryina</i> cf. <i>niigataensis</i> ASANO	—	.4	—	—	.1	—	—	—	—
<b>CALCAREOUS (PORCELAINOUS) FORAMINIFERA</b>									
Nubeculariidae									
<i>Cornuspira involvens</i> (REUSS)	—	—	—	—	—	—	—	.3	R
<i>Vertebralina striata</i> D'ORBIGNY	—	—	.5	—	R	—	—	—	R
Miliolidae									
<i>Quinqueloculina agglutinans</i> BRADY (not D'ORBIGNY)	.2	—	.9	—	.2	—	—	R	—
<i>Q.</i> <i>costata</i> D'ORBIGNY	—	—	—	—	R	—	—	—	—
<i>Q.</i> cf. <i>elongata</i> NATLAND	—	—	—	—	—	—	—	.4	.3
<i>Q.</i> <i>parkeri</i> BRADY	—	—	.5	.6	.1	R	R	R	.2
<i>Q.</i> cf. <i>subarenaria</i> CUSHMAN	—	—	—	.6	.2	—	—	—	—
<i>Q.</i> cf. <i>vulgaris</i> D'ORBIGNY	—	—	.4	.6	—	—	—	—	—
<i>Q.</i> cf. <i>yabei</i> ASANO	.3	—	—	—	.2	—	—	.1	R
<i>Q.</i> cf. <i>daintiensis</i> ASANO	—	—	.2	—	.3	—	—	—	—
<i>Q.</i> cf. <i>Sigmoinopsis schlumbergeri</i> (SILVESTRI)	—	—	—	—	—	—	—	R	.3

Stations	Beach sand					Mori Harbor			
	Wakura	Shiraki	Nishihro	Seto	Kubimoto	3	2	1	4
Depth (m)	0	0	0	0	0	2.9	6.4	7.0	8.6
% of sand content in sediment	100	100	100	100	100	45	66	65	70
Benthonic Population in 5 g of dried sediment	15	485	443	174	2884	340	514	732	528
<i>Quinqueloculina</i> sp. A	—	—	5	—	.9	—	—	—	—
Q. sp. B	—	—	—	—	.1	—	—	—	—
Q. sp. C	—	—	—	—	—	—	—	—	1
<i>Miliolinella circularis</i> (BORNEMANN)	.8	—	R	—	.3	—	—	4	4
M. <i>oceanica</i> (CUSHMAN)	—	—	R	—	—	—	—	—	—
M. (?) cf. <i>circularis</i> (BORNEMANN)	—	—	—	—	—	—	2	2	3
<i>Triloculina</i> cf. <i>anconensis</i> SCHULTZE	—	—	2	—	—	—	—	—	—
T. <i>berthelotiana</i> (BRADY)	—	—	2	—	—	—	—	R	—
T. cf. <i>gracilis</i> D'ORBIGNY	.4	—	—	—	—	—	—	—	—
T. <i>irregularis</i> (D'ORBIGNY)	—	—	—	—	—	R	—	R	R
T. <i>striatotrigonula</i> PARKER & JONES	—	—	—	—	—	—	—	—	R
T. <i>terquemiana</i> (BRADY)	—	—	2	—	.7	—	.2	—	—
T. <i>tricarinata</i> D'ORBIGNY	—	—	.7	—	.2	—	—	—	—
T. <i>trigonula</i> (LAMARCK)	11	—	.2	—	.3	—	—	.1	.6
<i>Pyrgo</i> cf. <i>denticulata</i> (BRADY)	—	—	—	—	—	—	—	—	R
<i>Miliolinella</i> cf. <i>sublineata</i> (BRADY)	—	—	3	—	—	—	—	—	—
<i>Spiroloculina</i> cf. <i>acescata</i> CUSHMAN	—	—	—	—	—	—	—	—	.2
S. <i>communis incisa</i> CUSHMAN	—	—	—	—	.1	—	—	—	—
S. <i>corrugata</i> CUSHMAN & TODD	—	—	.2	—	.1	R	—	—	R
S. <i>foevolata</i> EGGER	—	—	—	—	R	—	—	—	—
S. <i>hadai</i> THALMANN	—	—	.2	—	.1	—	—	—	—
S. <i>manifesta</i> ASANO (not CUSHMAN & TODD)	—	—	—	—	—	—	—	R	.4
<i>Articulina fijiensis</i> CUSHMAN	—	—	—	—	—	—	—	.1	.2
<i>Hauerina bradyi</i> CUSHMAN	—	—	6	—	—	—	—	—	—
H. <i>pacifica</i> CUSHMAN	2	—	R	.6	.3	—	—	R	R
H. <i>fragilissima</i> (BRADY)	—	—	—	—	R	—	—	—	—
Soritidae	—	—	—	—	—	—	—	—	—
<i>Peneroplis pertusus</i> (FORSKAL)	—	—	—	—	R	—	—	R	—
<i>Marginopora hemprichii</i> (EHRENBERG)	—	—	17	.6	R	—	—	—	—
CALCAREOUS (HYALINE) FORAMINIFERA									
Nodosariidae	—	—	—	—	—	—	—	—	—
<i>Lagena perlucida</i> (MONTAGU)	—	—	—	—	—	—	—	.1	R
L. <i>striata strumosa</i> REUSS	—	—	—	—	—	—	—	R	R
<i>Robulus</i> sp.	—	—	—	—	.1	—	—	—	—
Polymorphinidae	—	—	—	—	—	—	—	—	—
<i>Guttulina kiiensis</i> UCHIO, n. sp. (MS.)	7	—	—	—	R	—	—	—	—
G. sp.	—	—	—	—	—	—	—	—	R
<i>Globulina wakauraensis</i> UCHIO, n. sp. (MS.)	.8	—	—	—	—	—	—	—	—
G. sp. A	—	—	—	—	R	—	—	—	—
<i>Pyrulina cylindroides</i> (ROEMER)	.4	—	—	—	—	—	—	—	—
Glandulinidae	—	—	—	—	—	—	—	—	—
<i>Oolina acuticosta</i> (REUSS)	—	—	—	—	—	—	—	—	.2
O. <i>bifurcata</i> (LEROY)	—	—	—	—	R	—	—	—	—
O. <i>melo</i> D'ORBIGNY	—	—	—	—	R	—	—	—	—
<i>Fissurina</i> cf. <i>cucurbitasema</i> LOEBLICH & TAPPAN	—	—	—	—	—	—	—	—	.4
F. <i>kiiensis</i> UCHIO, n. sp. (MS.)	—	—	—	—	R	—	—	—	—
Turriliniidae	—	—	—	—	—	—	—	—	—
<i>Buliminella elegantissima</i> (D'ORBIGNY)	—	—	—	—	—	.9	5	5	6
<i>Buliminoides williamsoniana</i> (BRADY)	—	—	—	—	R	—	—	—	—

Stations	Beach sand					Mori Harbor			
	Wakaura	Shiraki	Nishihiro	Seto	Kushimoto	3	2	1	4
Depth (m)	0	0	0	0	0	2.9	6.4	7.0	8.6
% of sand content in sediment	100	100	100	100	100	45	66	65	70
Benthonic Population in 5 g of dried sediment	15	485	443	174	2884	340	514	732	528
<b>Bolivinitidae</b>									
<i>Bolivinita quadrilatera</i> (SCHWAGER)	—	.6	—	—	—	—	—	—	—
<i>Bolivinitella folia</i> (PARKER & JONES)	—	—	—	—	R	—	—	—	—
<i>Bolivina</i> cf. <i>pacifica</i> CUSHMAN & McCULLOCH (young)	—	—	—	—	—	—	—	1	.2
<i>B.</i> cf. <i>pseudoplicata</i> HERON-ALLEN & EARLAND	—	—	—	—	—	—	—	2	.8
<i>B.</i> cf. <i>robusta</i> BRADY	—	—	—	—	—	—	—	.3	.2
<i>B.</i> cf. <i>striatula</i> CUSHMAN	—	—	—	—	—	—	2	2	4
<i>B. rhomboidalis</i> (MILLETT)	—	—	—	—	R	—	—	—	R
<i>B.</i> sp. A	—	—	—	—	—	—	.2	—	—
<i>B.</i> sp. B	—	—	—	—	—	—	.2	—	—
<i>Sigmavirgulina tortuosa</i> (Brady)	—	—	—	—	R	—	—	—	R
<i>Virgulina</i> cf. <i>schreibersiana</i> CZJZEK	—	—	—	—	—	—	—	.1	1
<i>Loxostomoides karrerianum</i> (BRADY)	—	.2	—	.6	1	—	—	—	—
<i>L.</i> aff. <i>mayori</i> (CUSHMAN)	—	—	—	—	—	—	—	.3	—
<i>L.</i> (?) aff. <i>durrandii</i> (MILLETT)	—	—	—	—	—	—	.6	.3	.2
<i>L. limbatum costulatum</i> (CUSHMAN)	—	—	—	—	R	—	—	—	—
<i>Rectobolivina</i> sp. A	—	—	R	—	.1	—	—	—	—
<b>Buliminidae</b>									
<i>Bulimina marginata</i> D'ORBIGNY	—	.2	—	—	—	—	.2	.5	—
<i>B.</i> sp. (young)	—	—	—	—	—	.3	.8	—	1
<i>B.</i> (?) aff. <i>Trimosina orientalis</i> CUSHMAN	—	—	—	—	—	—	—	1	1
<i>Trimosina otukai</i> UCHIO	—	—	—	—	—	—	—	.4	.4
<i>Mimosina</i> (?) sp.	—	—	—	—	—	—	—	R	R
<i>Reussella aculeata</i> CUSHMAN	—	—	—	.6	.1	—	.6	.1	.9
<i>R.</i> simplex CUSHMAN	—	—	.2	—	.3	—	—	—	—
<i>Chrysalidinella dimorpha</i> (BRADY)	—	—	.2	—	—	—	—	—	—
<i>Pavonina flavelliformis</i> D'ORBIGNY	—	—	—	—	.1	—	—	—	R
<b>Uvigerinidae</b>									
<i>Uvigerina</i> sp.	—	.2	—	—	—	—	—	—	—
<i>Angulogerina kiiensis</i> UCHIO, n. sp. (MS.)	—	.2	—	—	R	—	—	—	R
<i>Hopkinsina pacifica</i> CUSHMAN	—	—	—	—	—	—	1	.5	2
<i>Siphogenerina raphanus</i> (PARKER & JONES)	—	—	—	—	.2	—	—	—	—
<i>Neouvigerina porrecta</i> (BRADY)	—	—	—	—	R	—	—	—	—
<b>Discorbidae</b>									
<i>Rosalina bradyi</i> (CUSHMAN)	—	.2	.5	.6	1	—	—	—	.2
<i>R.</i> vilardeboana D'ORBIGNY	—	—	—	—	—	—	—	1	2
<i>Glabratella pulvinata makinoi</i> (UCHIO)	—	—	—	—	.2	—	—	—	—
<i>G.</i> (?) sp.	—	—	—	—	—	—	—	.1	—
<i>Angulodiscorbis quadrangularis</i> UCHIO	—	—	—	—	R	—	—	—	—
<i>Pileolina</i> (?) <i>australensis</i> (HERON-ALLEN & EARLAND)	—	—	—	—	.3	—	—	—	—
<i>P.</i> (?) <i>opercularis</i> (D'ORBIGNY)	—	.2	—	—	R	—	—	—	—
<i>P.</i> (?) <i>opercularis nakamurai</i> (ASANO)	—	—	.2	.6	.1	—	—	—	—
<i>P.</i> (?) <i>patelliformis</i> (BRADY)	—	—	.5	.6	R	—	—	—	R
<i>Discopulvinulina</i> cf. <i>araucana</i> (D'ORBIGNY)	—	—	—	—	R	—	—	—	—
<i>Neoconorbina terquemiana</i> (RZEHA)	—	—	—	—	R	—	—	—	—
<i>N.</i> cf. <i>parkeri</i> (NATLAND)	—	—	—	—	—	—	—	—	R
<i>Eponides orientalis</i> ASANO	—	—	—	—	R	—	—	—	—
<i>Poroeponides cribroropandus</i> ASANO & UCHIO	—	.2	—	—	.5	—	—	—	—
<b>Planorbulinidae</b>									
<i>Planorbulina mediterraneanensis</i> D'ORBIGNY	—	—	1	—	.6	—	—	—	.2
<i>P.</i> acervalis BRADY	—	—	R	—	—	—	—	—	—



Stations	Beach sand					Mori Harbor			
	Wakura	Shiraki	Nishihiro	Seto	Kushimoto	3	2	1	4
Depth (m)	0	0	0	0	0	2.9	6.4	7.0	8.6
% of sand content in sediment	100	100	100	100	100	45	66	65	70
Benthonic Population in 5 g of dried sediment	15	485	443	174	2884	340	514	732	528
<b>Rotaliidae</b>									
<i>Ammonia beccarii asanoi</i> UCHIO	28	.2	3	—	13	76	61	40	26
<i>A. beccarii kiiensis</i> UCHIO, n. var. (MS.)	—	—	—	—	2	—	—	—	—
<i>A. erinacea</i> (HERON-ALLEN & EARLAND)	—	—	—	—	—	.3	9	8	6
<i>A. aff. inflata</i> (SEGUENZA)	—	3	—	—	—	—	—	—	—
<i>A. nipponica</i> (ASANO)	—	37	—	2	2	—	—	—	—
<i>A. tanabensis</i> UCHIO, n. sp. (MS.)	—	—	—	—	—	—	—	R	R
<i>Pseudorotalia</i> (?) <i>gaimardii</i> (D'ORBIGNY)	—	.2	—	—	R	—	—	—	—
<b>Elphidiidae</b>									
<i>Elphidium advena</i> (CUSHMAN)	15	—	—	—	.2	.9	.2	—	—
<i>E. cf. advena depressulum</i> CUSHMAN	6	—	—	—	—	2	1	4	4
<i>E. craticulatum</i> (FICHTEL & MOLL)	1	—	10	6	2	—	—	—	—
<i>E. crispum</i> (LINNÉ)	.4	31	19	2	17	—	—	.1	—
<i>E. cf. hokkaidoense</i> ASANO	1	—	—	—	R	.9	2	.8	2
<i>E. jenseni</i> (CUSHMAN)	15	—	2	—	7	—	—	.1	R
<i>E. subincertum</i> ASANO	.8	—	—	—	R	1	7	10	9
<i>E. cf. subgranulosum</i> ASANO	1	—	—	—	—	—	2	1	2
<i>E. spp. (young)</i>	—	—	—	—	—	—	—	3	3
<b>Nummulitidae</b>									
<i>Camerina ammonoides</i> (GRONOVIVS)	—	—	—	.6	—	—	—	—	—
<b>Anomalinidae</b>									
<i>Anomalina glabrata</i> CUSHMAN	—	—	.2	—	R	—	—	—	—
<b>Amphisteginidae</b>									
<i>Amphistegina lessonii</i> D'ORBIGNY	—	—	4	71	.1	—	—	—	—
<b>Cymbaloporidae</b>									
<i>Cymbaloporetta bradyi</i> (CUSHMAN)	—	—	2	—	1	—	—	—	—
<b>Nonionidae</b>									
<i>Nonion cf. granuliferum</i> (TERQUEM)	—	—	—	—	—	—	—	—	.2
<i>N. cf. boueanum</i> (D'ORBIGNY)	—	—	—	—	R	—	—	R	.2
<i>N. cf. japonicum</i> ASANO	—	—	—	—	—	—	—	—	.2
<i>Nonionella stella</i> CUSHMAN & MOYER	—	—	—	—	—	—	—	.1	R
<i>Pseudononion grateloupi</i> (D'ORBIGNY)	—	—	—	—	—	—	—	R	R
<i>P. cf. japonicum</i> (ASANO)	3	—	—	—	.3	—	—	.3	2
<i>Astrononion cf. gallowayi</i> LOEBLICH & TAPPAN	—	—	—	—	—	—	—	R	R
<b>Cassidulinidae</b>									
<i>Cassidulina depressa</i> ASANO & NAKAMURA	—	—	—	—	—	—	.4	1	1
<i>C. sp. A</i>	—	—	—	—	R	—	—	—	—
<i>C. subglobosa</i> BRADY	—	.6	—	—	.1	—	—	—	—
<i>Epistominella cf. sandiegoensis</i> UCHIO	—	—	—	—	—	—	—	2	2
<b>Cibicididae</b>									
<i>Cibicides lobatulus</i> (WALKER & JACOB)	—	.6	.2	—	.2	—	—	—	—
<i>C. cf. pseudoungerianus</i> (CUSHMAN)	—	.4	—	—	.6	—	—	—	R
<i>C. refulgens</i> (MONTFORT)	—	9	3	2	24	—	.2	—	—
<i>Hanzawaia nipponica</i> ASANO	—	2	—	—	.2	—	—	—	—
<b>Spirillinidae</b>									
<i>Patellina corrugata</i> WILLIAMSON	—	—	—	—	—	—	—	.1	—
<i>Spirillina vivipara</i> EHRENBERG	—	.2	—	—	—	—	—	.1	—

Table 2. Some characteristics of the sediment samples.

	Beach Sand				Mori Harbor			
	Wakaura	Nishihiro	Seto	Kushimoto	3	2	1	4
Depth (m)	0	0	0	0	2.9	6.4	7.0	8.6
Sand Content (%)	100	100	100	100	45	66	65	70
Benthonic Foram. Population in 5 g of dry sediment	15	443	174	2884	340	514	732	528
Arenaceous Foram.	0.4%	2%	4%	9%	18%	6%	5%	5%
Calcareous (Porcelainous) Foram.	19.2	45.3	8.4	17.6	R	2.2	7	12.2
Calcareous (Hyaline) Foraminifera	80.4	52.7	87.6	73.4	82	91.8	88	82.8
Miliolidae	19	32	8	17	R	2	7	17
Elphidiidae	42	31	8	25	5	12	18	20
Rotaliidae plus Discorbidae	28	4	4	19	76	70	49	33
Buliminidae plus Bolivini- tidae plus Uvigerinidae	0	2	1	2	1	10	16	19
Polymorphinidae	8	0	0	0	0	0	0	R
Amphisteginidae	0	4	71	0.1	0	0	0	0
Miscellaneous Families	3	21	5	3	0	0	5	0
Tropical Foraminifera	3	48	80	10	0.3	11	9	10

Thus, the beach sand is characterized by high percentages of *Elphidium* and Miliolidae except at Ezura and Seto where *Amphistegina lessonii* is predominant. Rotaliidae (mostly *Ammonia*) and Anomalinidae (mostly *Cibicides*) are also important in beach sand. Harbour samples are mud and are characterized by predominance of Rotaliidae (mostly *Ammonia*, particularly *A. beccarii* var.). *Elphidium* and Buliminidae are also important in the harbor samples except at Station 3 which is located in the inner part of the harbor.

(2) Percentages of tropical to subtropical species (such as *Textularia kerimbaensis*, *Vertebralina striata*, *Quinqueloculina parkeri*, *Miliolinella oceanica*, *Triloculina berthelotiana*, *T. irregularis*, *T. terquemiana*, *Spiroloculina corrugata*, *S. foevolata*, *Articulina fijiensis*, *Hauerina bradyi*, *H. fragilissima*, *H. pacifica*, *Peneroplis pertusus*, *Marginopora hemprichii*, *Buliminoides williamsoniana*, *Bolivina folia*, *Bolivina rhomboidalis*, *Sigmavirgulina tortuosa*, *Loxostomoides mayori*, *L. durrandii*, *Trimosina orientalis*, *Reussella simplex*, *Pavonina flavelliformis*, *Hopkinsina pacifica*, *Glabratella pulvinata makinoi*, *Angulodiscorbis quadrangularis*, *Pileolina* (?) *australensis*, *P. (?) opercularis*, *P. (?) patelliformis*, *Planorbulina mediterraneensis*, *P. acervalis*, *Ammonia erinacea*, *Elphidium craticulatum*, *Camerina ammonoides*, *Amphistegina lessonii*, *Cymbaloporeta bradyi*) in the foraminiferal assemblages are very small at Wakaura and Station 3 of Mori Harbor. This is because Wakaura is the northernmost locality among these samples and Station 3 is located in the inner part of Mori Harbor, and the both localities are not so strongly influenced

by the warm Kuroshio Current as at the other localities. The highest percentages of tropical species at Seto and Ezura (ca. 90%) may be due to the fact that the places are located close to a point called Bansho-no-saki and is directly influenced by the Kuroshio Current. On the contrary, relatively small percentages of tropical Foraminifera at Kushimoto is unexpected, because Kushimoto is located at the southernmost part of Honshu (main land of Japan). However, its low percentage may be due to the fact that the beach near Kushimoto Railway Station is protected from direct influence of the Kuroshio Current by Shio-no-misaki Peninsula (actually a barrier island) to the west and south, and by Oshima Island to the east.

(3) Among the four samples in and near Mori Harbor, Station 3 is located in the inner part of the harbor, its depth is the shallowest, its sand content is the smallest and, thus, its foraminiferal occurrence is different from that of the other stations. Population of benthonic Foraminifera at Station 3 is smaller than that at the other stations. Foraminifera assemblage at Station 3 is characterized by more abundance of arenaceous Foraminifera, particularly *Trochammina* cf. *globigeriniformis* which is characteristic of brackish waters in Japan (UCHIO, 1962), more abundance of *Ammonia beccarii* var., much less occurrence of *Elphidium* and Buliminidae, and by much less content of tropical to subtropical species. Milio-lidae, *Elphidium* and Buliminidae increase in abundance from Station 3 towards offshore, and *Ammonia beccarii* var. decreases from Station 3 towards offshore. Thus, Foraminifera distribution of Mori Harbor can be divided into two, inner and outer harbor, assemblages. In connection with the distribution of benthonic Foraminifera in Mori Harbor, YAMAZI's plankton study of Tanabe Bay (1958, 1959) is of interest. He made a quantitative analysis of the plankton of Tanabe Bay collected in November, 1956 and August, 1957. According to his results, "The distribution of plankton was found to be closely correlated with the hydrographical conditions... The stagnant inner water favors the development of dense zoo- and phyto-plankton communities which are composed chiefly of smaller organisms as compared with oceanic and neritic forms... Some of the inlet-water forms forming dense populations in the inner area and narrow arms are dispersed towards the entrance of the bay along the southern coast, northern shore and central area where they form tongue-like extension... These organisms (oceanic planktons) which occur abundantly outside the bay flow into the central area of the bay extend to the northeastern areas... The influx of the oceanic waters is not so strong as to influence the condition of the baylet waters... The plankton in inlet waters is used as indicator to distinguish water masses whose chemical and physical properties are unknown or too small to be analysed". Thus, YAMAZI's results are very similar to the writer's results based upon the benthonic Foraminifera.

(4) It is of interest to note that many species of benthonic Foraminifera of

Mori Harbor are in common with those of Recent sediments in Aburatsubo Cove, Miura-shi, Kanagawa-ken and also with those of the Pleistocene shell bed at a great cliff facing Tokyo Bay, at Sakurai, Kisarazu-shi, Chiba-ken. The detailed description of them will be made in another paper in the near future.

In the identification of the Foraminifera species listed in Table 1, the writer has compared his specimens with those of Recent sediments from Dry Tortugas (Florida, U.S.A.), Bermuda, Jamaica, Andros Island (Bahama), Hawaii, New Zealand, Australia, Red Sea and England. Most of these samples are a part of materials from which CUSHMAN originally described his species here in concern. The writer has found several new species (listed in Table 1), but number of specimens of some species are not sufficient and the description of them will be given in another paper very soon.

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### Postscript

After examining more materials at these localities, rare occurrences of the following species are noted:

Shiraki....."*Discorbis*" *australis* PARR, *Buccella* (?) cf. *nipponica* (HUSEJIMA & MARUHASI), *Sigmoidella kagaensis* CUSHMAN & OZAWA, *Cassidulina* sp. B, and *Hyalinea balthica* (SCHROETER)

Kushimoto...*Siphoninoides glabra* (HERON-ALLEN & EARLAND), *Gypsina vesicularis* (PARKER & JONES), and *Cibicides kiiensis* UCHIO, n. sp. (MS.)

Mori Harbor Station 4...*Rectobolivina virgula* (BRADY)

Thus, in addition to the 37 species listed (see page 141), *Rectobolivina virgula*, *Loxostomoides limbatus costulatus*, *Siphoninoides glabra* and *Gypsina vesicularis* should be included in tropical to subtropical species.

Another interesting thing to be noted is that the species found in Mori Harbor are usually smaller and have thinner tests than the species found at the beach sand. This fact does not mean that the harbor environment is unfitted for the growth of Foraminifera, and this interpretation can be supported by the relatively larger population of Foraminifera in the harbor samples than in the beach sand (see Table 1 or 2). Very large population at Kushimoto is due to special sampling as mentioned elsewhere in this paper. The small, fragile (thin-walled), and yet, abundant Foraminifera of the harbor sediment can be interpreted that they are well fitted to the quiet and muddy bottom of the harbor. In this connection, PHLEGER's (1960) suggestion is very interesting: "BRADSHAW (1957) found in experimental cultures of Foraminifera that specimens grown under optimum conditions reproduced rapidly but were always small in size. In contrast, specimens cultured under conditions near their limits of survival grew to large size but did not reproduce. LANKFORD (1959) found that the large populations off the Mississippi Delta, living under presumably optimum conditions, are composed of small specimens. This suggests that the idea of the "depauperate fauna", i.e., one composed of small specimens, may *not* indicate adverse conditions of the environment but may be the result of a very favorable environment".